

MANAGEMENT OF OVER-RETAINED MANDIBULAR DECIDUOUS SECOND MOLARS WITH AND WITHOUT PERMANENT SUCCESSORS

The objective of this article is to describe the various clinical situations of prolonged retention of mandibular deciduous second molars. Indications for orthodontic space closure in the absence of permanent successors and treatment alternatives in space opening, including retaining the deciduous molars, are described. Periodic monitoring, composite buildups, and indications and timing of extraction of infraoccluded and ankylosed deciduous molars with and without permanent successors are reviewed. World J Orthod 2008;9:209–220.

A deciduous molar should spontaneously exfoliate when approximately three-fourths of the root of the replacing premolar has formed.^{1,2} When a deciduous molar persists beyond this point, it is considered over-retained. Common local causes for over-retained deciduous teeth are malposition of the tooth germ, abnormal resorption of the roots, ankylosis, supernumerary teeth in the path of eruption, and agenesis of the replacing tooth.³ The aim of this article is to describe the various clinical situations of over-retained mandibular deciduous second molars, review management concepts and ideas including those where no complete consensus exists, and address optimal treatment timing and acceptable treatment alternatives.

The most important factor in the management of over-retained deciduous molars is whether the permanent successor is present or congenitally missing.

AGENESIS OF THE PREMOLAR

The frequency of missing teeth varies with the population investigated, but several studies have suggested that excluding third molars, the second premolar is the most common congenitally absent tooth.⁴ An early diagnosis of absent second premolars is not always possible because of late calcification. The dental follicle and/or cusp tip should be visible on bitewing radiographs by age 8; however, mandibular second premolars can develop as late as 14 years of age in some cases.⁵

Space closure versus space opening

The 2 treatment approaches commonly used for congenitally missing second premolars are space opening or space closure so that natural teeth touch each other^{6–8} (Fig 1). Space closure is defi-

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Fig 1 Orthodontic space closure for congenitally missing mandibular second premolars.



Fig 2 Missing mandibular right second premolar. Keeping a healthy deciduous second molar is a viable treatment alternative in certain situations.



nately a more attractive solution in young patients because of the permanence of the end result. However, the treatment should depend on the basic orthodontic diagnosis.⁹ Space closure is usually indicated in extraction cases with space deficiency, incisor proclination, and full-lip profile. The missing premolars are considered as if they had been extracted to relieve crowding or protrusion. For patients with nonextraction features, early extraction of the deciduous molar has been suggested in order to favor spontaneous space closure, which is more likely to occur in the maxilla.^{5,10-12} However, second premolars may not have calcified yet when extraction is optimal. It is therefore preferable to delay extraction until orthodontic treatment.

Controlled slicing and hemisection with the removal of the distal half of the second deciduous molar followed by the mesial half have also been proposed to facilitate anchorage loss (mesial drift of molars) and avoid adversely affecting the profile.¹³⁻¹⁵

Premolar autotransplantation

Autotransplantation is also a viable treatment alternative for growing patients, when a premolar must be extracted for orthodontic reasons in 1 arch but there is no need to extract in the opposing arch where a premolar is missing.¹⁶ Another clinical application for autotransplantation in extraction cases is when 4

Fig 3 Retained deciduous mandibular second molar in a 50-year-old patient.

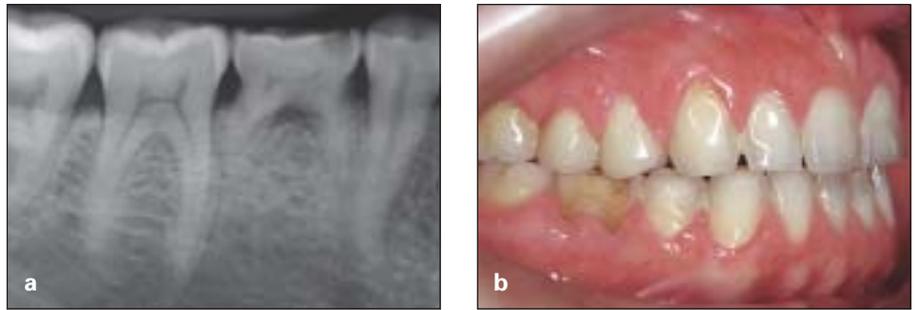
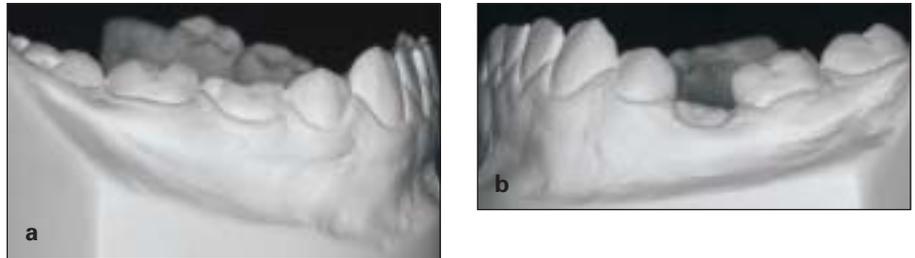


Fig 4 Missing mandibular second premolars and retained deciduous second molars. (a) Good space and bone maintenance (right side). (b) Ankylosis and space loss (left side).



teeth are missing in 1 arch, maxillary lateral incisors and second premolars for example, while all teeth are present in the mandibular arch: the mandibular second premolars can be transplanted in the site of the maxillary second premolars. In nonextraction cases, even third molar transplants have been described as substitutes for missing premolars.¹⁷ For the most predictable results, donor teeth should have completed approximately one-half to three-quarters of root development.¹⁸

Retaining deciduous molars

In space maintaining or opening, the most common restorative option for missing premolars in patients with sound adjacent teeth is a single-tooth implant.⁹ An additional viable treatment option, not possible with missing laterals, is keeping healthy deciduous molars (Fig 2). Many reports exist of deciduous molars surviving in patients who are 40 or even 60 years of age¹⁹⁻²² (Fig 3). Stud-

ies have shown that if deciduous molars are present at 20 years of age, they seem to have a good prognosis for long-term survival.²⁰ Root shortening of retained mandibular deciduous second molars was found to be negligible over many years.²² In fact, the average length of time they can be retained rivals the lifespan of some prosthetic restorations.²² However, because deciduous second molars are larger than the replacing premolars, their mesiodistal width must be reduced to approximately 7 mm in order to get an optimal Class I interdigitation at the molars.²³ The limiting factor of such a reduction is the divergence of the deciduous molar roots. As a result, a compromised molar occlusion will result in certain situations, as teeth cannot move any closer than their roots allow (Fig 2). Retained deciduous second molars are the best space and alveolar bone maintainers if implants are to be considered (Fig 4a). However, for unknown reasons, they can occasionally become ankylosed and infraoccluded (Fig 4b).

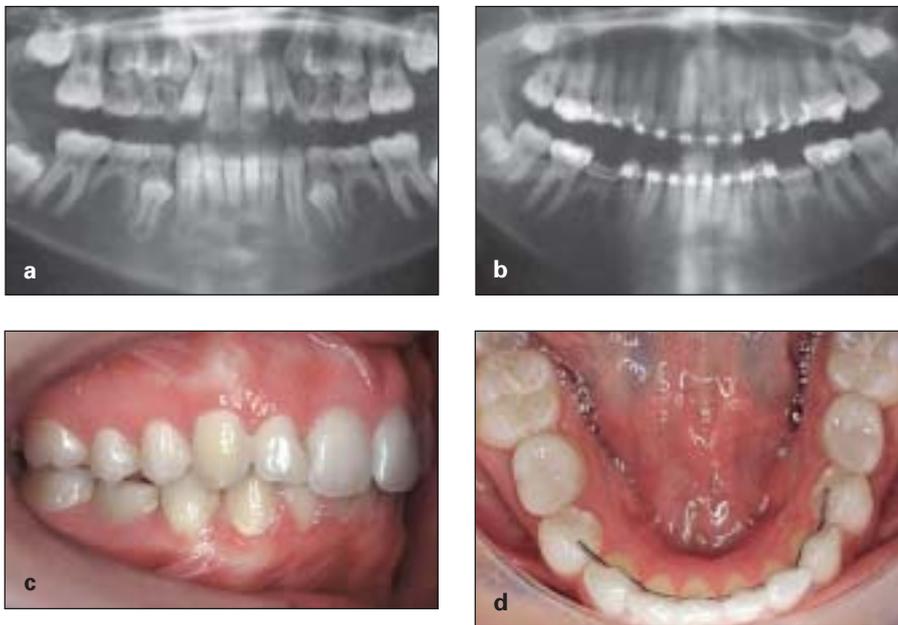


Fig 5 (a) Missing mandibular second premolars. (b) Late ankylosis of the deciduous second molars. (c and d) Composite buildups on the infraoccluded deciduous molars.

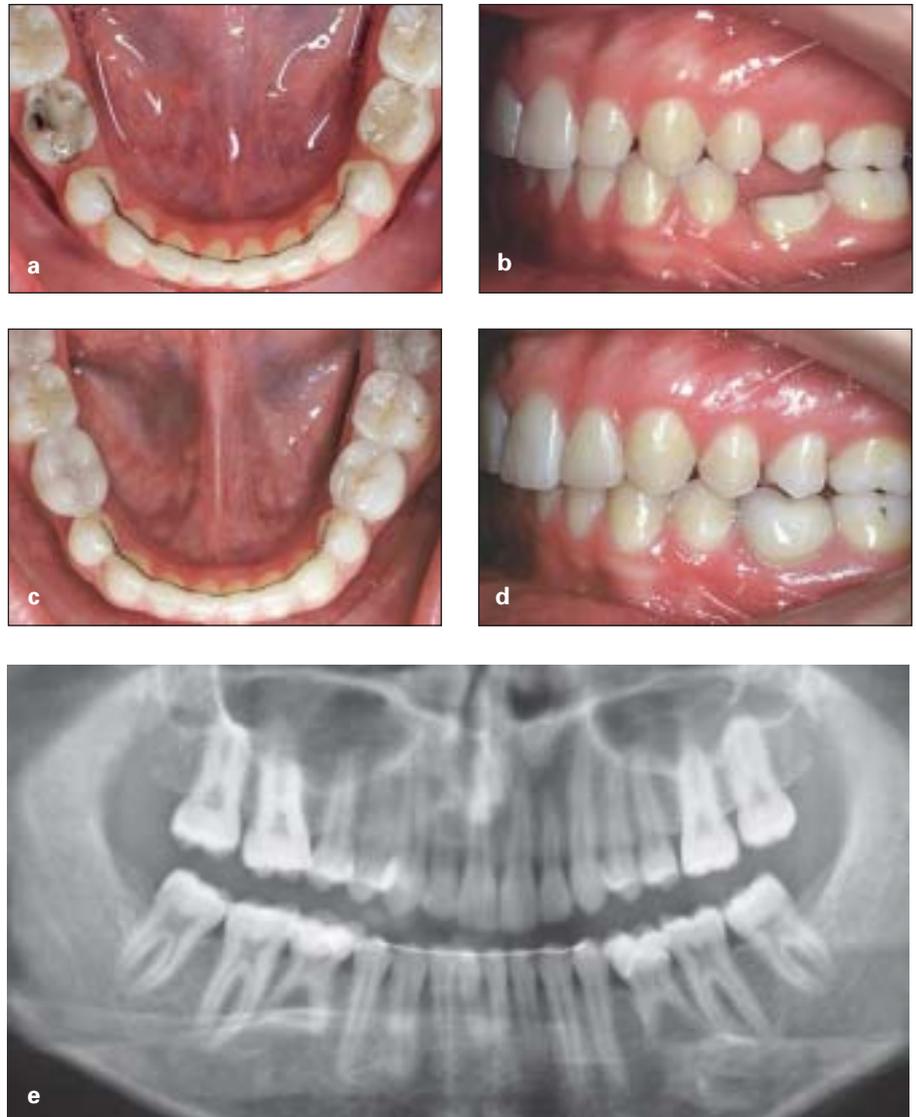
The infraoccluded deciduous molar

Infraocclusion of a deciduous molar is the cessation of eruption without a physical barrier or ectopic position of the tooth at some point after emergence.²⁴ Infraoccluded teeth remain stationary while eruption of adjacent teeth continues with growth and occlusal development. The most commonly affected teeth are the mandibular deciduous second molars.²⁴ Infraocclusion usually appears in the early mixed dentition, and the prevalence has been reported to be 8% to 14% between 6 and 11 years of age.²⁵ The earlier it occurs, the more severe the infraocclusion with the tooth gradually becoming more in infraposition. This might result in tipping of adjacent teeth, space loss, and overeruption of opposing teeth. Infraoccluded deciduous molars with no successors showed a slowing of root resorption with age and did not exfoliate spontaneously like infraoccluded teeth with permanent successors.²⁵ Progressive resorption can lead to eventual tooth loss. For many years, infraoccluded teeth were regarded as a source of disturbance, and extraction was widely advo-

cated. However, as ankylosis seems to be associated with infraoccluded teeth, loss of alveolar bone following extraction can be severe and may complicate future restorative and orthodontic treatment.²⁶

A clinician must be able to recognize a developing infraocclusion in the mixed dentition and determine what steps should be taken when. A small step in the occlusal plane does not confirm ankylosis, as deciduous molar crowns are naturally shorter than those of adjacent permanent first molars.²⁶ Percussion is not a reliable method of detection, nor is the absence of mobility. Radiographically, there may be obliteration of the periodontal membrane space; however, this is not a consistent feature because fusion to the bone may occur over only a small area that goes undetected with routine periapical radiographs. The best sign of true ankylosis is when the interproximal bone level is dipping apically around the infraoccluded tooth.²⁷ If the interproximal bone level is flat, the tooth is probably erupting at the same rate as the adjacent tooth. Conversely, if the bone level between the permanent and the deciduous tooth is oblique, the tooth is ankylosed.

Fig 6 (a and b) Missing mandibular second premolars with ankylosed and infraoccluded deciduous second molars in a distal malposition. **(c to e)** A ceramic onlay to close the residual mesial space.



Management of an infraoccluded deciduous molar with absence of a successor depends on the patient's age and gender and the tooth's expected mesiodistal position at the end of orthodontic treatment. A deciduous molar can start submerging any time between 7 and 13 years of age. If infraocclusion starts developing in a 13-year-old female, when most of the facial growth is completed, the vertical step is not usually severe but easily manageable with a direct composite buildup on the deciduous molar to reestablish tooth contact with the opposing tooth (Fig 5). Progression of the infraocclusion was shown to be slower in older children, with a mean increase of $0.5 \text{ mm} \pm 0.26 \text{ mm}$ per

year.²⁵ Now what if, in a similar 13-year-old female, the deciduous second molars start submerging during orthodontic treatment and leave a small space between them and the first premolars after the canines were seated in Class I and an optimal overbite and overjet were achieved (Figs 6a and 6b)? Because of the ankylosis, the deciduous molars cannot be moved orthodontically to consolidate the space. A ceramic onlay may be a suitable restorative option to build up the occlusal surface and establish a contact with the first premolar²⁸ (Figs 6c to 6e). An ideal Class I molar relationship will not be possible because of the distal position of the second deciduous molar in addition to its larger size relative to the

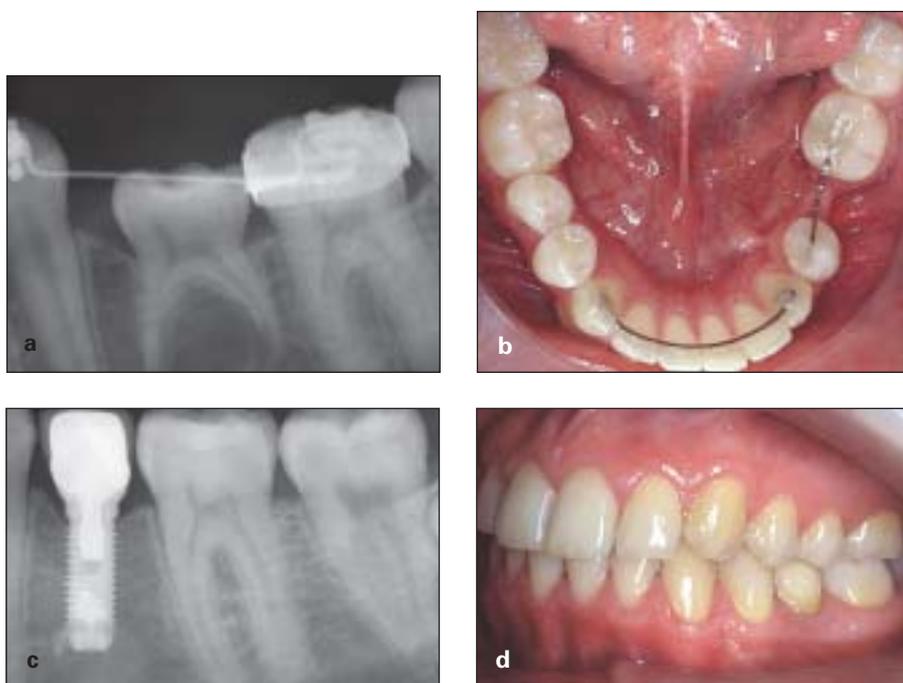


Fig 7 (a) Ankylosed deciduous second molar in a distal malposition. (b) Space management after deciduous molar extraction. (c and d) Single-tooth implant in an optimal mesiodistal position leading to a full Class I molar relationship.

replacing premolar (Fig 6b). For a similar situation where an infraoccluded deciduous second molar is even more distal, leaving a space too large to be closed prosthetically (Fig 7a), extraction and implant placement would be the appropriate solution (Fig 7c). Adequate space for a prosthetic premolar can be created and an optimal Class I molar relationship achieved (Figs 7b and 7d). The single-tooth implant is a more reliable long-term solution than a retained deciduous molar, but the disadvantages include higher treatment fees and a longer treatment time.

Timing of infraoccluded deciduous molar extraction

What would be the outcome if the same infraocclusion occurred in a 13-year-old male but was overlooked or left untreated? Because males continue to grow until they are 18 years or older, the infraocclusion will progress and most likely become severe enough to preclude a prosthetic solution (Figs 8a and 8b). Delaying extraction until the end of

growth will likely result in a severe vertical bone defect (Figs 8c and 8d). The implant position would have to be deep and the clinical crown long with unfavorable crown-to-root ratio (Figs 8e and 8f). Alternative treatments for such bone defects include bone grafting or implant-site development by moving the first premolar into the second premolar space and placing an implant in the newly formed bone at the first premolar site.²³ Such bodily tooth movement with low and continuous forces necessitates longer treatment time. In order to avoid severe vertical bone defects, deciduous molars should be extracted when the infraocclusion is first noticed while considerable amount of growth remains. In fact, research has shown that the alveolar ridge at the extraction site will move occlusally with the adjacent teeth as they continue to erupt.²⁹ The stretching of the periosteum over the ridge stimulates the osteoblastic activity necessary to continue alveolar ridge growth (Fig 9). Another concern following early extraction of second deciduous molars is alveolar ridge narrowing until the time of implant placement at the end of growth.

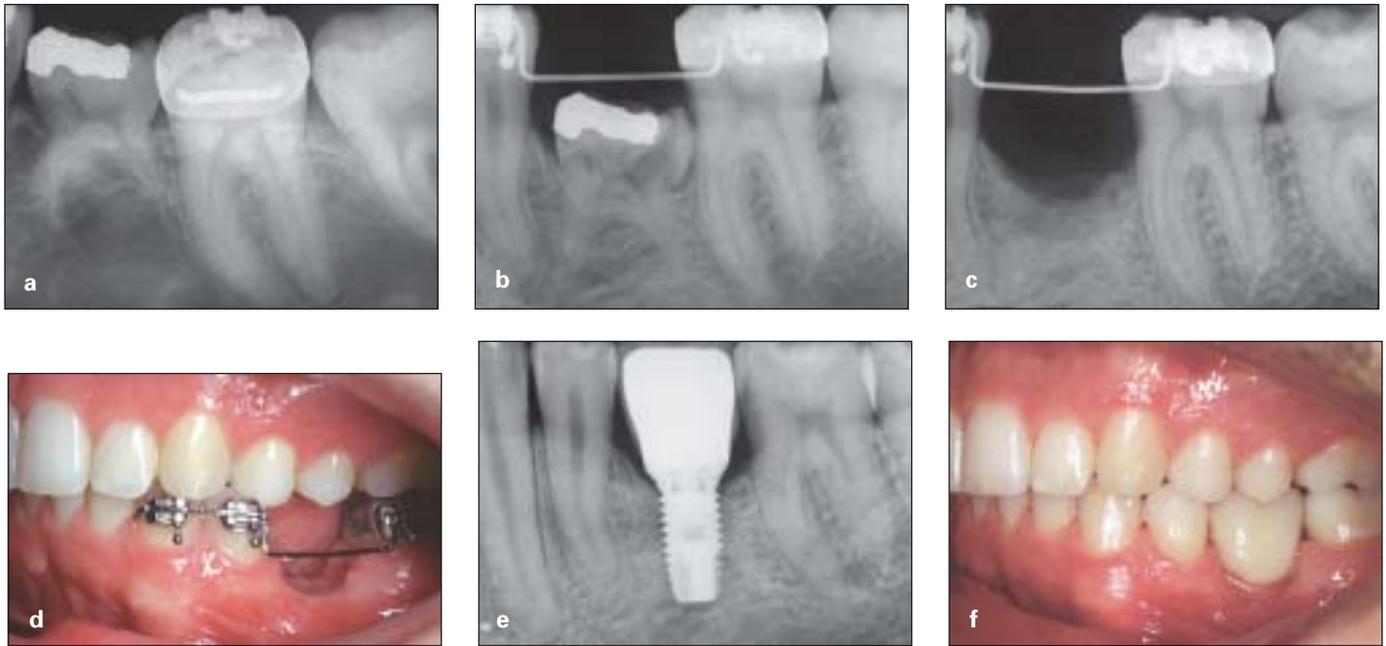


Fig 8 (a and b) Deciduous second molar developing ankylosis and infraocclusion. (c and d) Severe vertical bone defect due to late extraction of the deciduous molar. (e and f) Single-tooth implant with poor crown-to-root ratio and long clinical crown.

Fig 9 (a) Early ankylosis and infraocclusion of deciduous molars. (b) Oblique crestal bone level. (c) Erupting first premolars following early extraction of the ankylosed deciduous molars. (d) The crest of the ridge moved occlusally as the adjacent teeth continued to erupt.



Alveolar ridge width was found to decrease approximately 25% over a 3-year period (from 11.5 mm to 8.5 mm) and slowed over the next 4 years for an additional 4% loss of ridge width.²⁹ Therefore, delaying implant placement after early extraction of deciduous

molars should not be a problem, as ridge width stabilizes to the dimension of the first premolar after initial narrowing. The need to extract infraoccluded deciduous molars with no successors will depend on the patient's remaining facial growth at the time it is discovered.

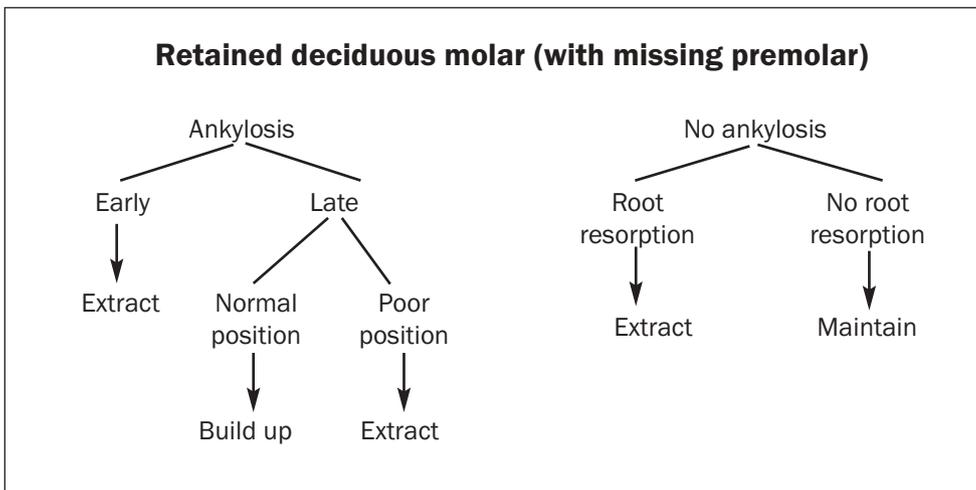


Fig 10 Treatment alternatives for retained deciduous second molars, in nonextraction cases, when second premolars are congenitally missing.

The treatment flowchart (Fig 10) can serve as a guideline for addressing the most common treatment options for over-retained mandibular deciduous molars when the permanent successors are congenitally missing.

PRESENCE OF THE PREMOLAR

Mandibular deciduous second molars are normally replaced by their permanent successors at age 11 years 6 months, according to group averages.³⁰ However, expected tooth eruption times (chronological age) as derived from tables are not reliable enough for practical clinical evaluation. The development status of an individual tooth cannot be evaluated from tables with norms from a group to which the child does not belong. To establish a diagnosis of over-retention, several aspects of tooth eruption relative to the individual patient should be sequentially examined: (1) the stage of root formation or biologic eruption; (2) the vertical position or height of the tooth bud; (3) the axial inclination or any positional deviation of the erupting premolar; (4) the stage of root resorption of the deciduous molar; (5) the eruption stage of the same tooth on the contralateral side; (6) the presence of physical obstructions in the eruption path, such as supernumerary teeth, odontomas,

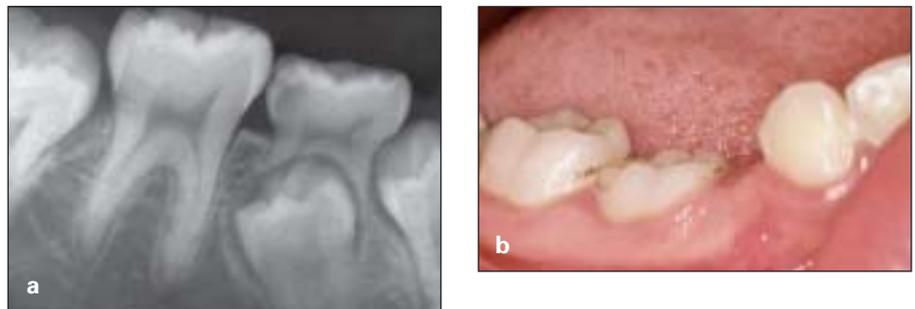
and tumors; and (7) infraocclusion/ankylosis of the deciduous molar.

Eruptive movements are closely clinically related to tooth development.^{1,31,32} Under normal circumstances, a premolar emerges through the gingiva when three-fourths of its final root length is established.¹ When a deciduous molar is extracted with its successor still in an apical position and prior to three-fourths root formation, eruption will be delayed because the alveolar process will reform atop the permanent tooth. Conversely, extraction of a retained deciduous molar will accelerate eruption when its successor is close to the ridge. A positional deviation or oblique axial inclination of the developing premolar can delay deciduous molar exfoliation (Fig 11). These deviations should be monitored; some will correct themselves following deciduous molar extraction, while significant migrations require orthodontic intervention.³³ Over-retention can also result from abnormal resorption of the deciduous molar. This differential resorption of the root is due to ectopic development of the tooth germ that can be genetically determined. A deciduous molar can be considered over-retained and should be thoroughly examined when the contralateral tooth has already been replaced, as variations between the right and left sides in terms of timing of eruption are minimal in most patients.³⁰

Fig 11 (a) Over-retained mandibular deciduous molar due to oblique axial inclination of the developing premolar. (b to d) Self-correction following extraction of the deciduous molar.



Fig 12 Ankylosis and infraoccluded deciduous molar impinging on adjacent tooth eruption.



Do infraoccluded deciduous molars become over-retained, and do they interfere with the normal development and eruption of their permanent successors? The literature is replete with articles reporting the negative consequences of long-standing and untreated infraoccluded deciduous molars.³⁴ Based mostly on case reports, delayed exfoliation,^{35,36} delayed eruption and impaction of successors,³⁷ ectopic eruption,^{36,38} disturbed root development,³⁹ space loss,^{36,40,41} and increased difficulties in extraction^{38,41} have all been reported to have resulted from untreated infraoccluded deciduous molars. On the other hand, other authors have stressed the fact that complications can occur following early extraction of infraoccluded deciduous molars and believe it is unnecessary in most cases.⁴² Longitudinal studies on the rate of deciduous root

resorption and development of permanent successors showed no difference between infraoccluded and normal deciduous molars.⁴³ Another longitudinal study on unilateral extraction in children with bilateral infraocclusion of deciduous molars showed no major difference in eruption time of successors between the extraction and the nonextraction side, which warrants a more conservative approach to extraction treatment of infraoccluded deciduous molars.³⁴ Infraocclusion can also be reversed if the area that causes the ankylosis is resorbed before the tooth becomes totally submerged.^{44,45} Despite differing opinions, the following clinical situations can be considered as clear-cut indications for extraction of infraoccluded deciduous molars when successors are present: (1) deciduous molar impinging on adjacent tooth eruption (Fig 12);



Fig 13 (a) Infraoccluded mandibular right second deciduous molar with permanent successor in wrong position. (b) Four months after second deciduous molars extraction and space maintenance. (c) Eruption of second premolars, 8 months later.



Fig 14 (left) Over-retained mandibular right second deciduous molar with no signs of root resorption 1 year after eruption time.

Fig 15 (above) Primary (intrabony) retention of a deciduous molar with no signs of root resorption and resultant space loss.

(2) permanent successor in the wrong position^{42,46} (Fig 13); (3) no sign of root resorption 1 year after eruption of the same successor tooth on the contralateral side⁴³ (Fig 14); (4) primary failure of eruption where the deciduous molar is covered with bone and shows no signs of root resorption⁴⁷ (Fig 15); and (5) severe tipping of adjacent teeth with a need for

space regaining.^{48,49} Bone loss following the extraction of severely infraoccluded deciduous molars should not be a concern because the erupting premolar brings bone with it. Whenever early extraction of a deciduous molar is indicated, space maintenance should be considered and overeruption of the antagonist premolar monitored (Fig 13).

CONCLUSIONS

Over-retained mandibular deciduous second molars are common encounters in clinical practice. The etiology of over-retention is multifactorial, and the presence or absence of the permanent successor is an important factor in the treatment decision. Depending on the basic orthodontic diagnosis, space closure or opening are the 2 treatment options for missing second premolars. For patients with nonextraction features, retaining a healthy deciduous molar is a viable treatment option. Occasionally, deciduous molars can become infraoccluded and ankylosed. When the infraocclusion occurs while a large amount of growth remains, early extraction is indicated to avoid a severe vertical bone defect. Late ankylosis can be compensated for with composite buildups. Retained deciduous molars can be good space and bone maintainers when single-tooth implants are planned. When the replacing premolar is present, over-retention of the deciduous molar is most commonly due to uneven root resorption or malposition of the tooth bud. Ankylosis and infraocclusion of the deciduous molar is believed to retard exfoliation and eruption of the successor tooth. This has been a controversial issue in the literature. Periodic observation is the recommended course of action for infraoccluded deciduous molars and extraction should be done in specific clinical situations, such as interference with adjacent tooth eruption, permanent successors in wrong position, primary retention with bone coverage of the deciduous tooth, and severe tipping of adjacent teeth.

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